

AMWG Overview

THE 26th CESM ANNUAL WORKSHOP

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14 JUNE 2021



OUTLINE

- Unified CAM/WACCM Vertical Grid resolution
- CPTs.
- Variable resolution work - South America, Polar regions
- Physics time-step reordering and Surface coupling frequency (spurious surface wind oscillations).
- Software Engineering Update
- Other topics and updates
- Summary

Unified CAM/WACCM configuration for climate/CMIP

(Isla Simpson, CAS)

Vertical resolution/model top

Reasonable 80km top (Dz=500m, 81L) exists (Isla Simpson, AMWG Feb 2021)

- QBO is OK, stratospheric zonal mean wind climate is OK
- Outstanding dry bias in upper tropospheric/lower-stratospheric water vapor

Developed cheaper version (~40km top, Dz=500m,48L) for tropospheric physics development

Added PBL levels (10) to 48L version

- Fixed instability in surface flux calculation (w/ W. Large)
- Modified ZM cloud-base formulation (Rich Neale, visit poster on Tuesday)

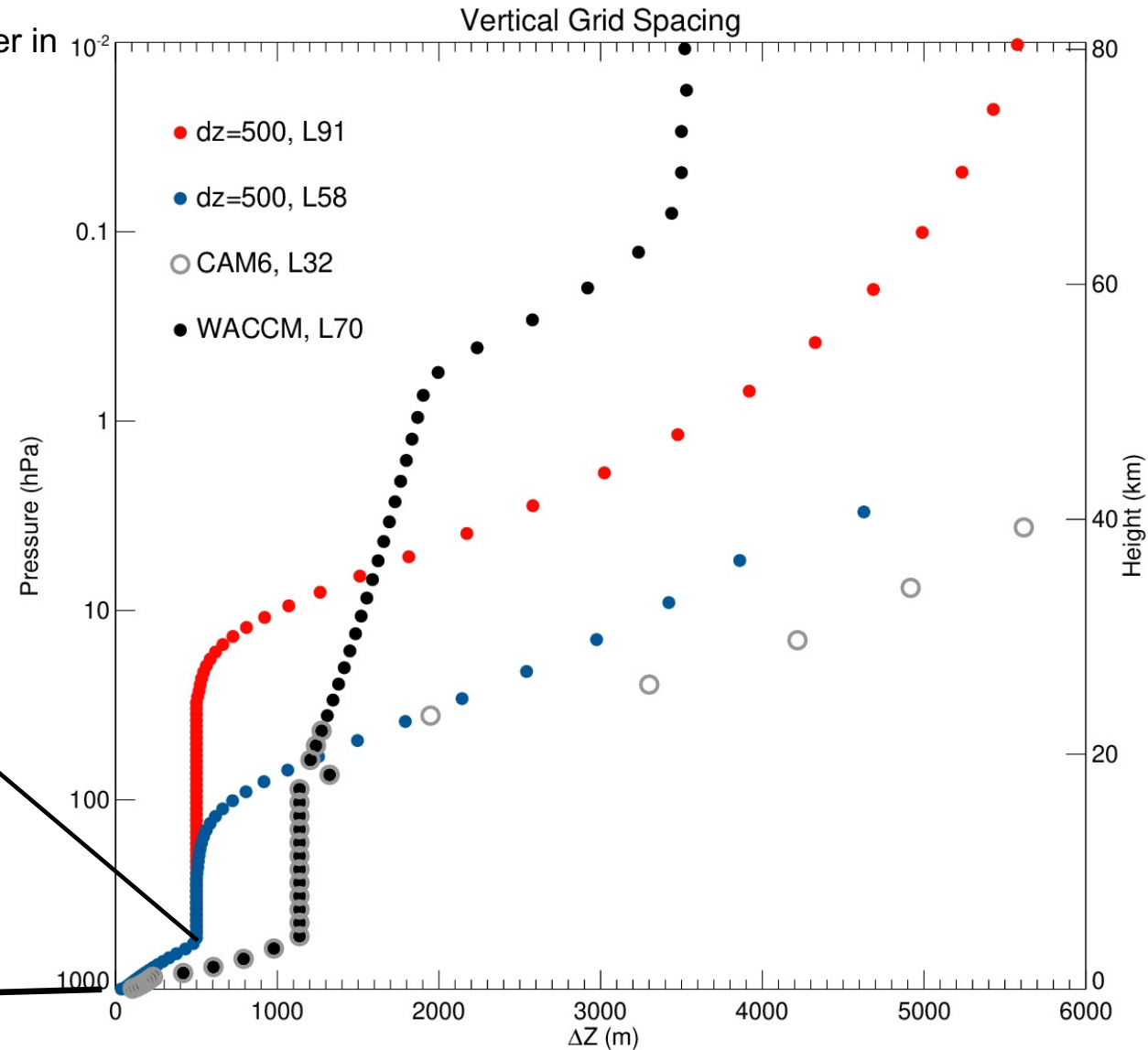
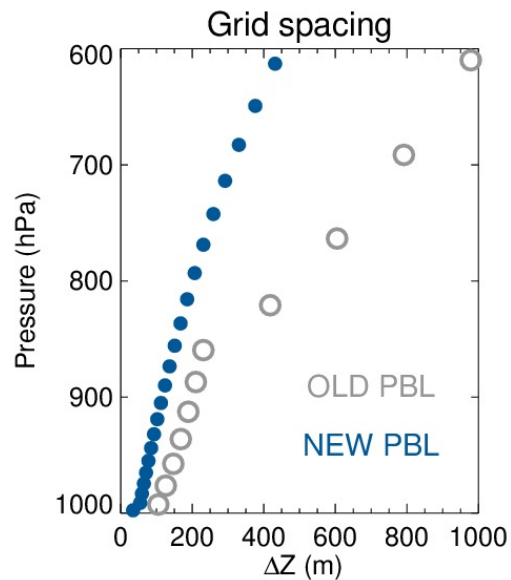
Now have a configuration (48L+10BL w/ ZM2) that we are reasonably happy with and will use "going forward". Remaining issues are:

- Reassess climate and stratospheric variability (and H₂O) in 81L+10BL w/ZM2
- CAM-SE mods impact on climate
- Final tuning needed for climate

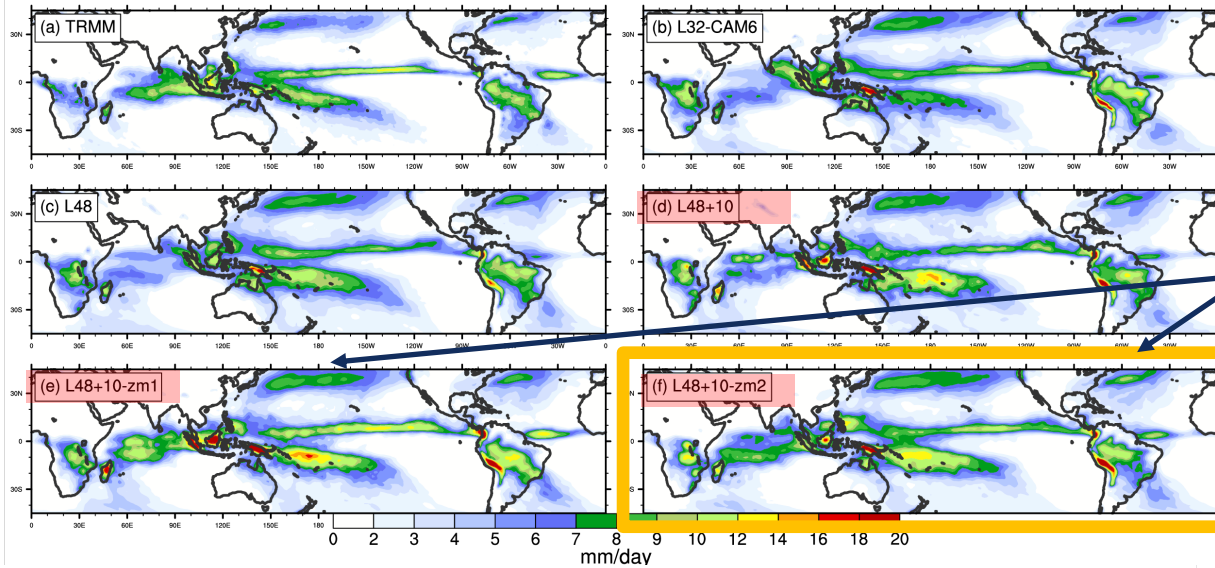
Motivation: Improve the representation of the stratosphere and boundary layer in our standard model for climate applications.

Improve/represent: QBO, stratospheric polar vortex, boundary layer clouds and moisture/temperature profiles, surface fluxes. Low enough top to be initialized from reanalyses

- ~80km top (91L=81L+10BL) or ~40km top (58L=48L+10BL)
- 500m grid spacing in the free troposphere and lower stratosphere
- 10 additional levels in the boundary layer
- New PBL resolution currently being tuned in CAM-SE with 40km top.



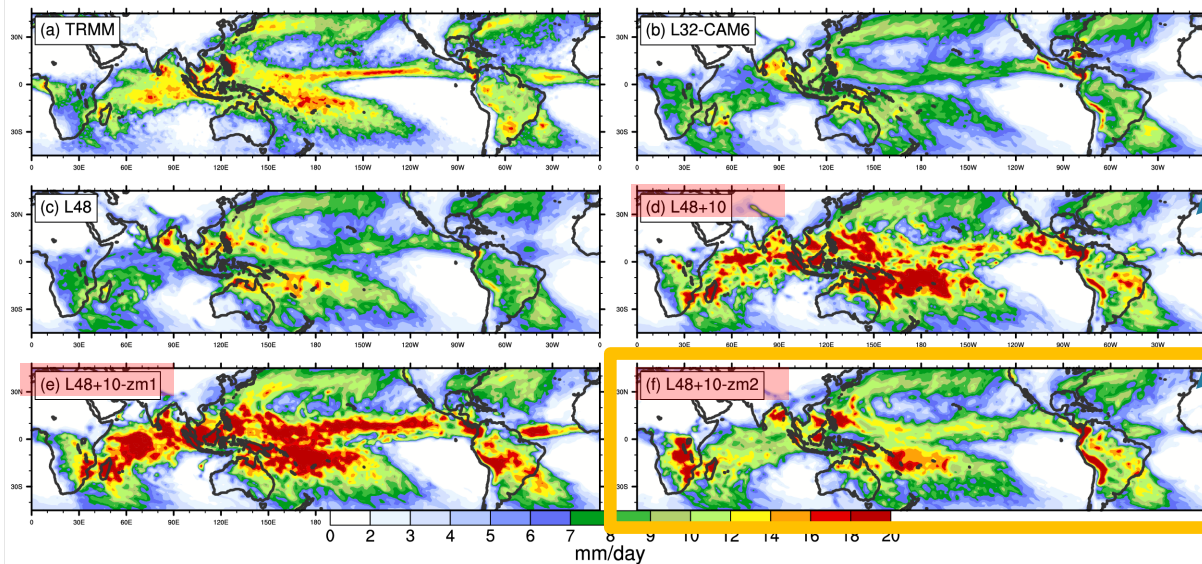
Mean - Precipitation - DJF



Results from increased PBL resolution in panels d-f ()

ZM cloud base properties calculated from dynamic average of several PBL layers (*Rich Neale, poster Tuesday PM*)

Standard deviation - Precipitation - DJF



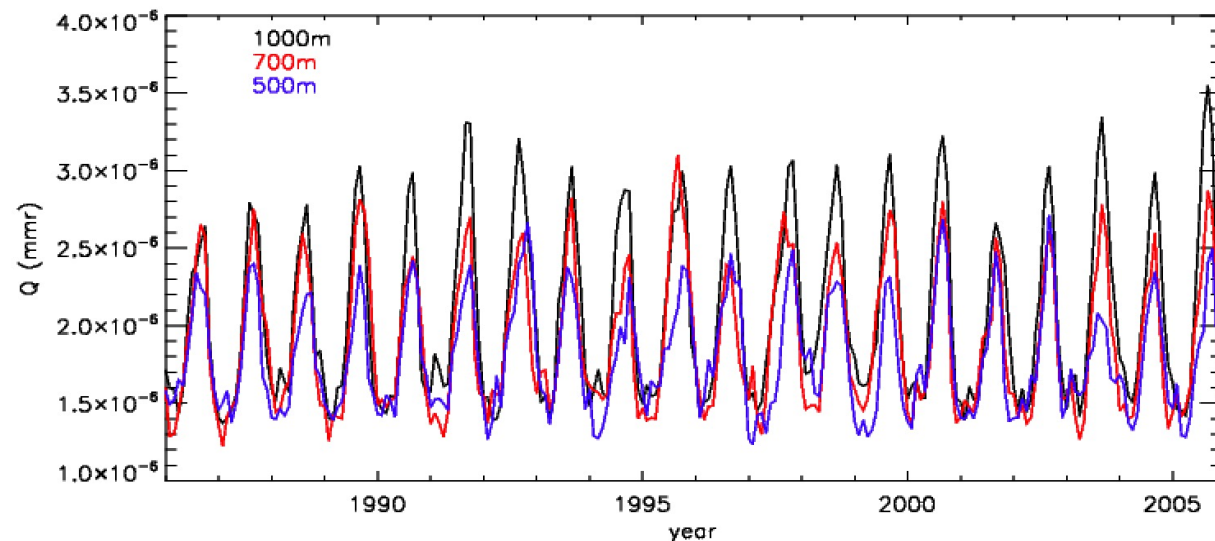
Precipitation variability becomes large when PBL vertical resolution is increased and ZM deep convection cloud base properties are still based only on lowest level

Defining ZM cloud base layer as $0.5 \times \text{PBLH}$ improves variability also yields improved mean precip (see panel f above)

Next steps for CAM/WACCM unified model

- Reassess climate and stratospheric variability (and H₂O) in 81L+10BL w/ZM2
- CAM-SE mods impact on climate
- Final tuning needed for climate
- Coupled runs (before next AMWG ??)

Cold-point H₂O mmr (specific humidity)



- During the wet phase Q decreases with increasing resolution
(Plot courtesy of Rolando Garcia)

NOAA/NSF CPTs (Climate Process Teams)

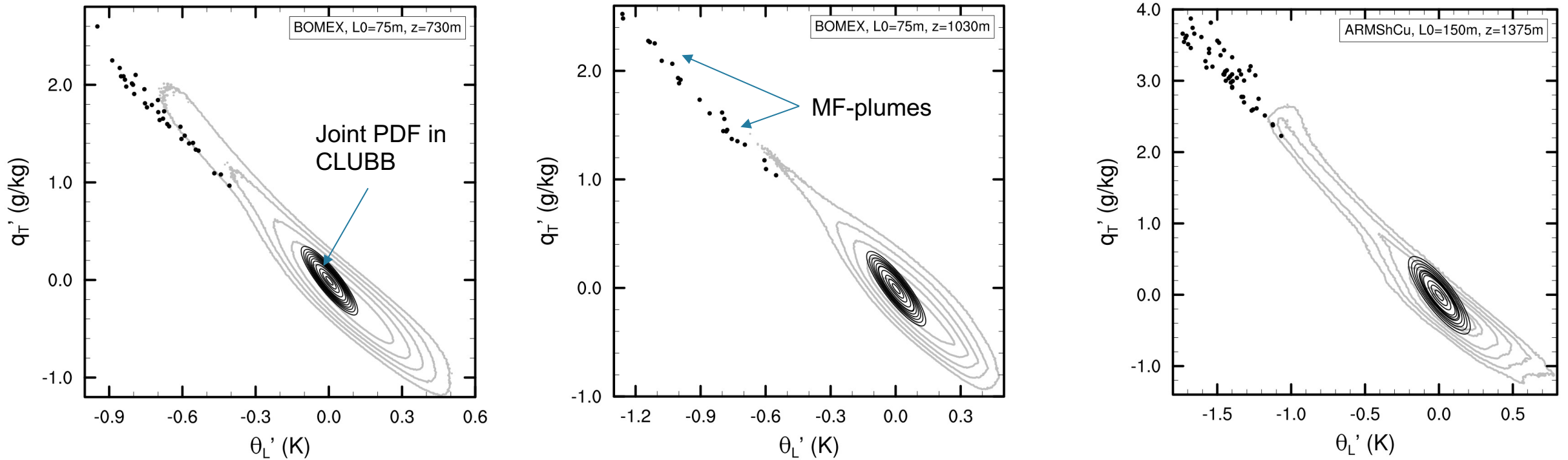
From Boundary Layer to Deep Convection: The Multi-Plume Eddy-Diffusivity/Mass-Flux (EDMF) Fully Unified Parameterization

Adam Herrington, NCAR

Mikael Witte, Naval Postgrad.

PI: Joao Teixeira, JPL/UCLA

Joint pdfs of q_T and θ_L from LES (light gray) and CLUBB-MF (black contours+dots)



Note qualitative agreement, e.g., slope/orientation between LES results and CLUBB-MF parameterization in BOMEX and ARM-ShCu cases

Update on CLUBB-MF by Joao Teixeira in AMWG Session, Tuesday AM

NOAA/NSF CPTs (Climate Process Teams)

Transport of momentum fluxes in the boundary layer*

Chris Kruse NCAR

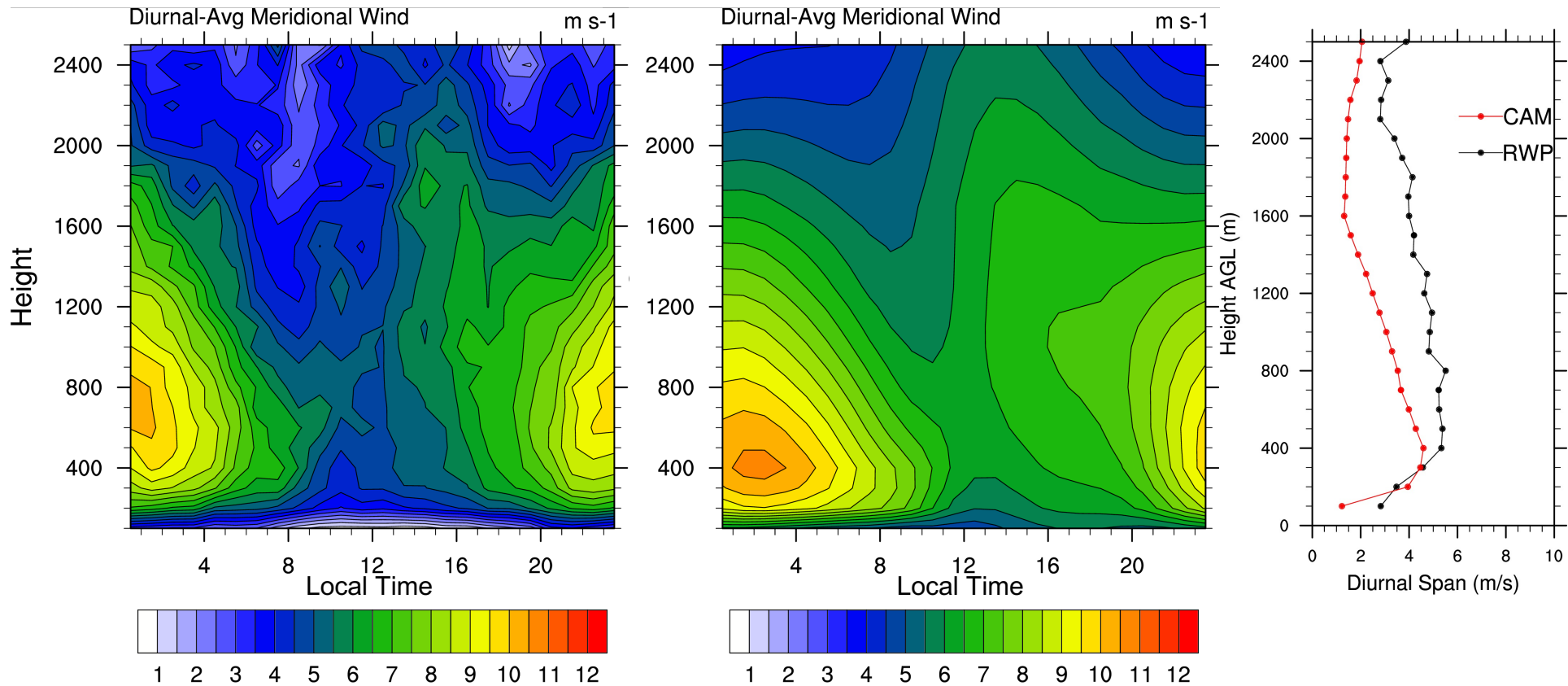
Vince Larson, U Wisconsin-Milwaukee

PI: Colin Zarzycki, Penn State

*CPT objective: To improve representation of momentum transport by CLUBB

May, June, July of 2010 Averages

Z,t sections of observed (left) and CAM (right) V



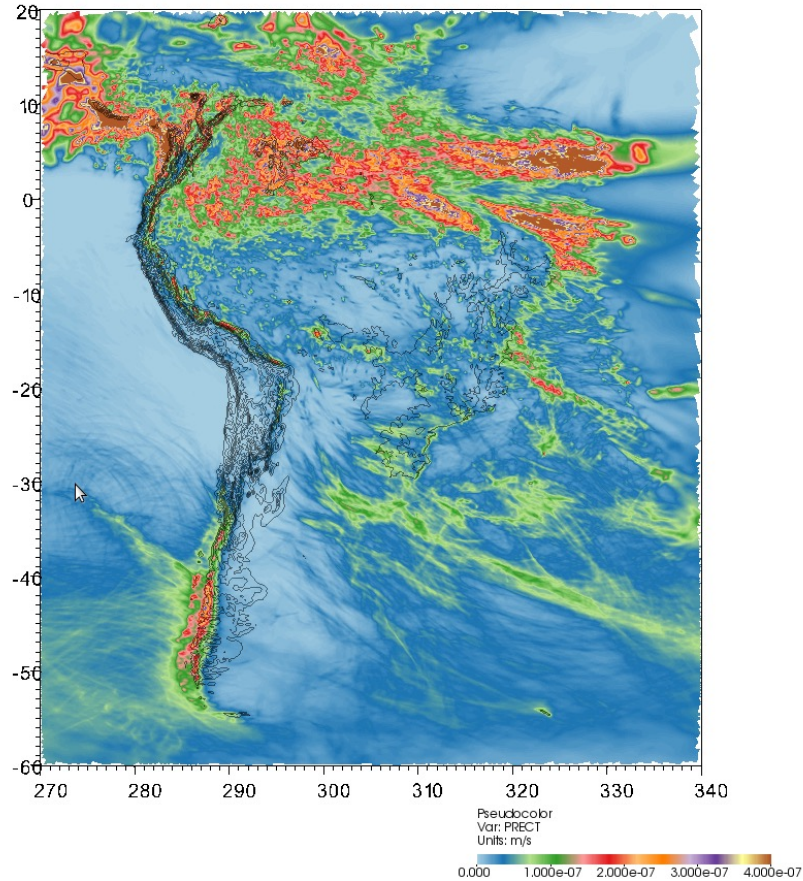
Diurnal cycle of meridional wind over Southern Great Plains ARM site in May-June 2010: **(left)** Observations; **(right)** In boundary forced CAM run (nudged everywhere except over central US).

Note good agreement in general pattern of diurnal (large-scale forcing) – but disagreement in height of max winds, amplitude of cycle ... *More in Colin Zarzycki's talk on Tuesday AM*

Variable Resolution efforts

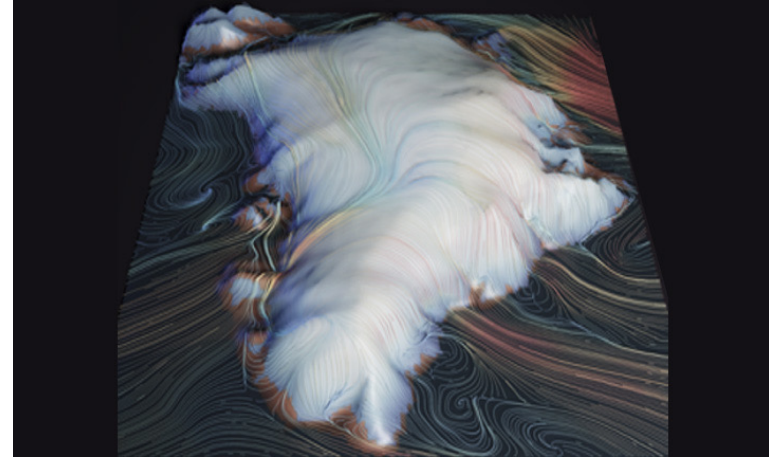
South America 6-km (ne480). *Developed for as “South America Affinity Group” collaboration led by R. Rasmussen RAL)*

L70 June Monthly Average Precip



(talk by Patrick Callaghan, SIMA Session Tuesday PM)

Greenland Ice-Sheet 12-km (ne240). *Developed in collaboration w/ Land-Ice Working Group: W. Lipscomb, J. Lennaerts and others*



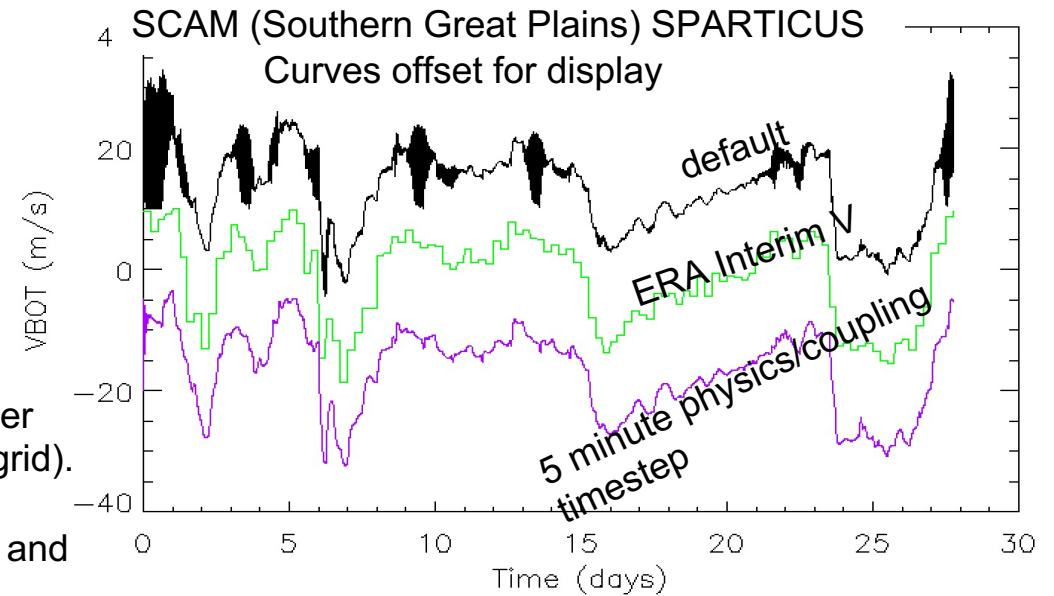
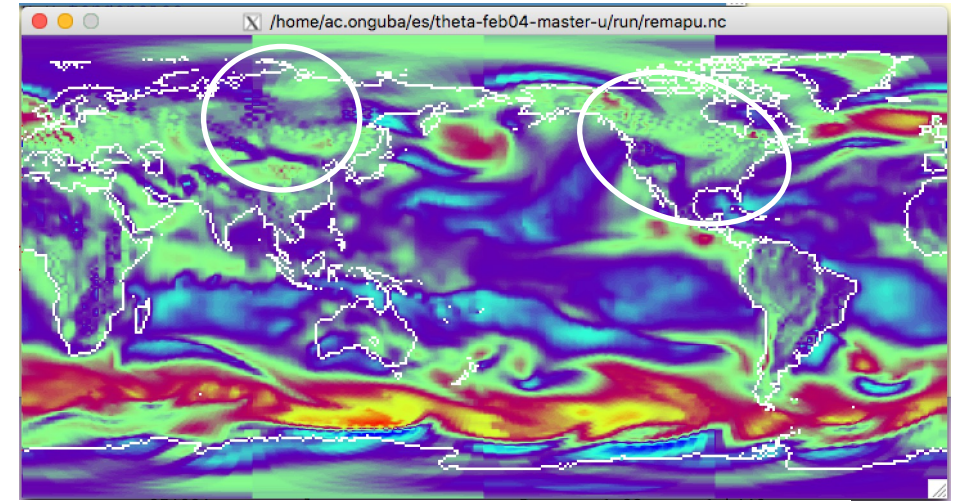
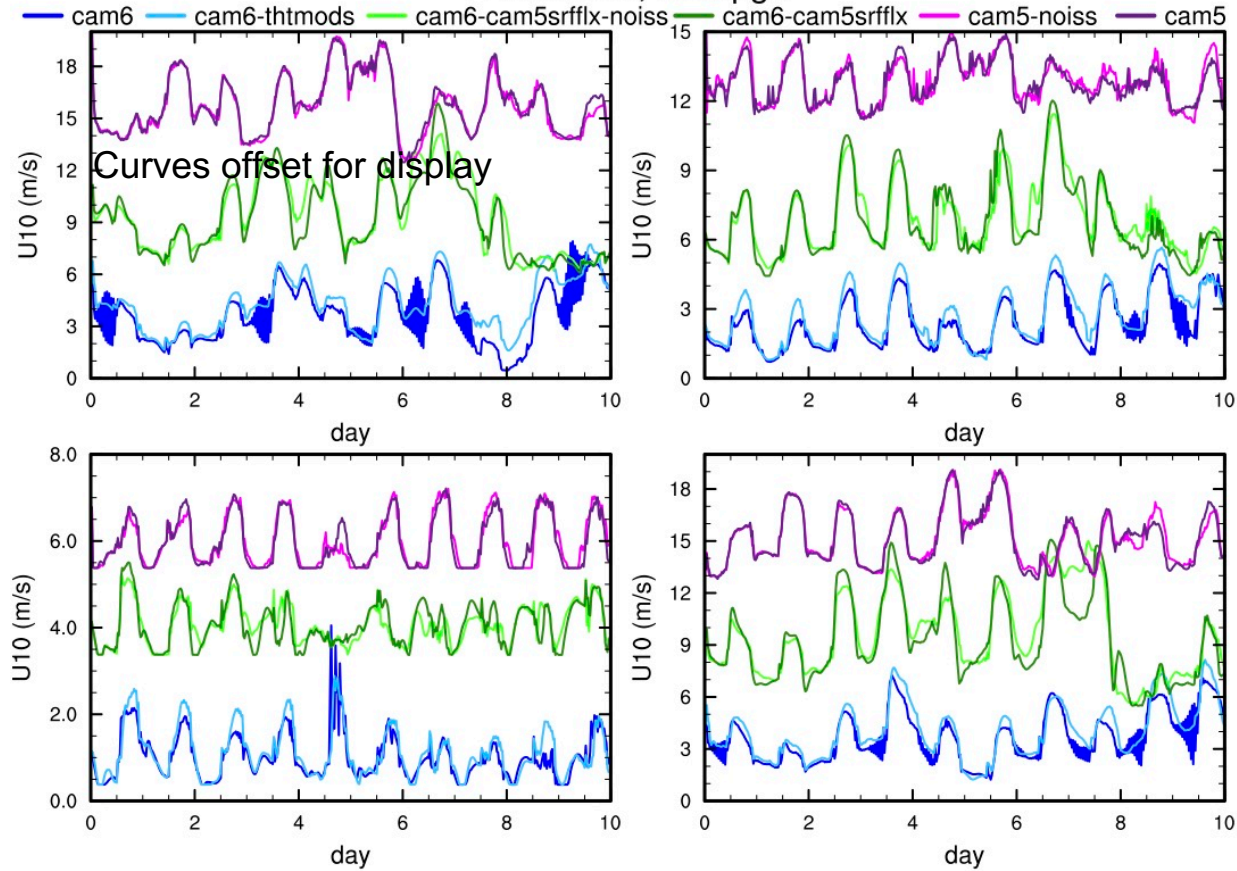
(talk by Adam Herrington, SIMA Session Tuesday PM)

Figures represent two major CGD and cross-lab (CGD/RAL/MMM) efforts using CAM-SE to study regional climate. More details in talks tomorrow.

Oscillations in low-level wind

E3SM (Sean Santos)

CAM6 (Brazil points)
F2000climo, ne30pg3

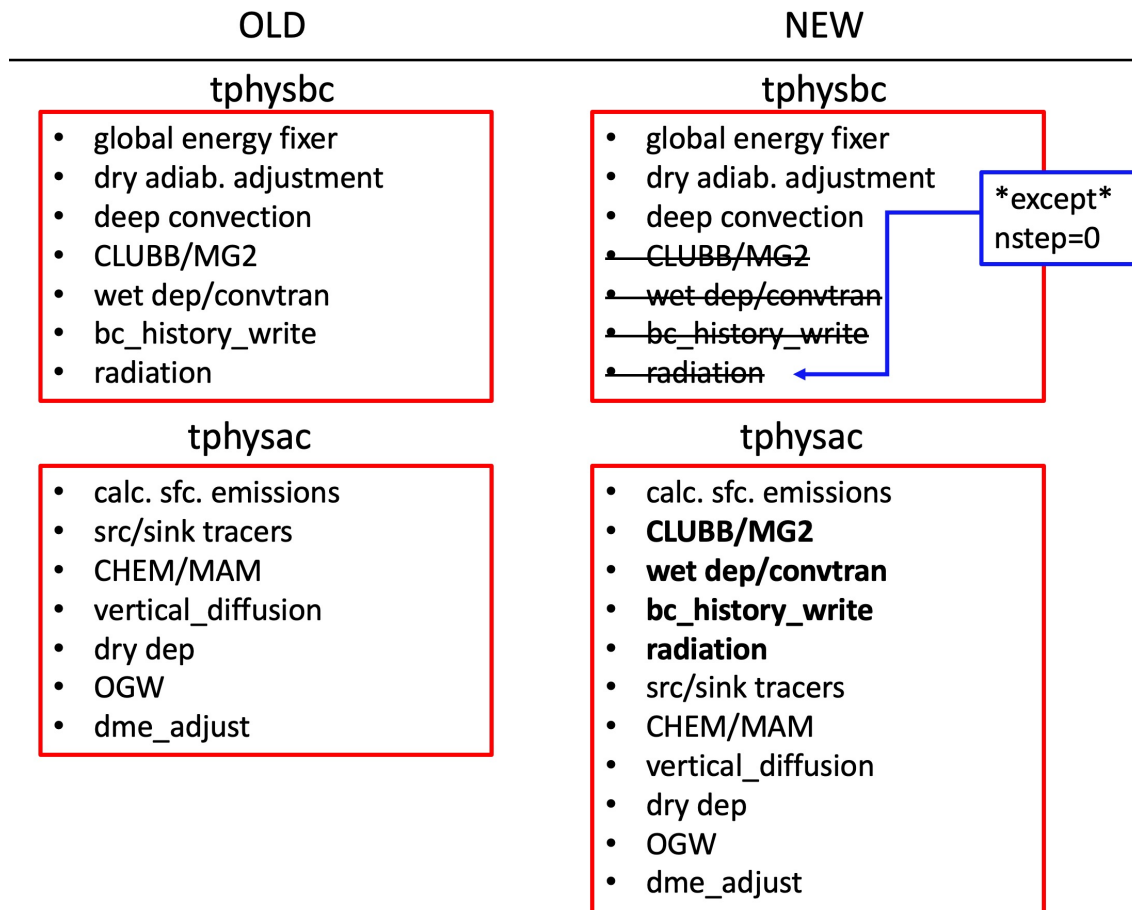


Two Dt oscillations are(/have been) present in surface wind in CAM6 at higher vertical resolution over land (and at low amplitude even in standard vertical grid).

Likely causes - too large physics timestep combined with inconsistent winds and surface drag due to process order

“Low-touch” solutions

reorder time loop (*Adam H.*)



Increase coupling frequency to $(5 \text{ min})^{-1}$

Expensive - not viable for climate sims

But

Is this an option for a “physics development” branch?

i.e., work on physics in a configuration that is well posed then worry about making it more economical later

Software engineering update

(S. Goldhaber)

CAM SE team made 35 development tags, 9 release tags for CESM2.1 and 18 release tags for CESM2.2.

- Major new features introduced include new dycores (FV3 and MPAS)
- New WACCM-X infrastructure allowing for use from different dycores, high resolution, and multi-instance runs
- New weak-scaling infrastructure which improves scaling performance for both memory and execution time
- New contrail parameterization
- Implementation of NUOPC cap (allows CAM to run in new CESM3 infrastructure)

Progress implementing Common Community Physics Package (CCPP) infrastructure in CAM

- New flexible infrastructure runs CCPP physics suites
- Physics test bench can run CCPP suite 'offline' (no dycore)
- AMP will begin porting CAM6 physics suite to CCPP in the second half of June.

Other CAM development work

- Implementing complete energy enthalpy for CESM (*P. Lauritzen, Tues. AM*)
- New Diagnostic packages (*B. Medeiros, Tues. AM*)
- Tuning Document (*C. Hannay, Tues. AM*)
- PUMAS microphysics (*A. Gettelman*)

Other highlights

- FV3 dynamical core included in CESM2.2 release
- Official dynamical core evaluation process for CESM is beginning (*I. Simpson, P. Lauritzen, C. Jablonowski ...*)
- Numerous updates to simpler-physics configurations: RCE, moist Held-Suarez (<https://www.cesm.ucar.edu/models/cesm2/whatsnew.html>)

CAM7 progress

- New Hire: *Yang Tian (convection param., LES ...)*
- South America grid for WRF intercomparison (*Callaghan, Neale, w/ RAL, MMM collaborators*)
- Perdigao LES/SCAM/Obs intercomparison underway (*Neale, Bacmeister w/ RAL, MMM collaborators*)

Summary

- Unified vertical grid development nearly complete
- CPTs underway – yielding promising results
- Major VR efforts underway with CAM SE
- Physics time step under scrutiny
- Transition to CCPP infrastructure possible soon